Single Cycle Instrument Placement

NASA Ames Research Center Computational Sciences Division

Single Cycle Instrument Placement (SCIP) is a research project at Ames Research Center's Computational Sciences Division that enables a rover to approach and place a science instrument on a rock or other science target in a single command cycle. The K9 test rover is a platform for the development and integration of technologies for future NASA missions. Using K9, a six-wheeled, solar powered vehicle, in 2002 and 2003, Ames researchers successfully demonstrated SCIP, from ground operations and planning to execution and science data capture. A test scheduled for 2004 includes a team of geologists that will determine goals for the rover to execute.

The following are SCIP technologies being integrated and tested on K9:

Navigation:
To approach the designated science target without help from mission control the rover must keep track of the target as it navigates. The rover uses images from its stereo cameras to build 3-D models of the terrain as it drives. Using a technique called 3-D model registration to compare and align the models built before and after moving, the rover can determine where it is in relation to the target.

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Planning:
The contingency planning software system starts with a set of human-generated science goals, and builds a plan to achieve the highest priority goals given the expected resources available. The system evaluates the plan to determine what might make the plan fail, given uncertainty in the time and resource consumption of the actions. The planner then considers other feasible science objectives, and introduces contingency branches to handle the potential failures. For all of this to happen a mission's staff introduces alternate goals in case the primary plan fails. The planner then determines under what conditions doing something other than the primary plan would be useful.

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Execution:
Onboard the rover, the conditional executive is able to consider a number of alternative conditions while it executes a plan. The software directs the rover to drive to sets of targets, deploy science instruments and take measurements. Along the way, the software monitors the rover's consumption of resources, and can spot danger or opportunity, and will select an alternative plan.

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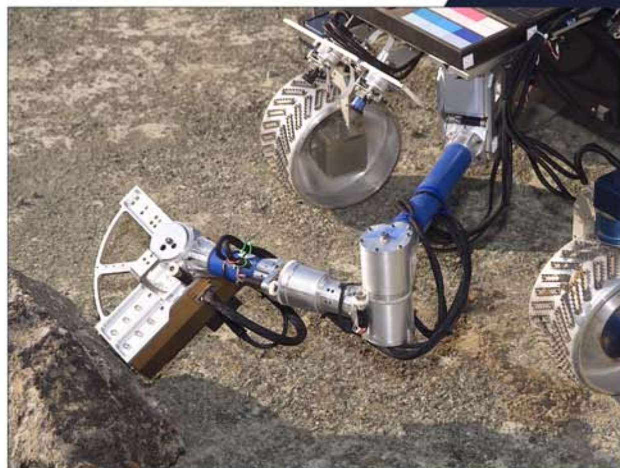

Problem solving:
Model-based fault management will maintain a vehicle's health and safety by detecting, diagnosing and solving problems. For example, while a rover explores Mars, its software might monitor its wheel speed and the battery's current draw. If the software determines the spinning is unintentional, the software will try to solve the problem, perhaps by telling the rover to back up. Or the software can contact mission control for help.

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Seeing Mars
A software package called Viz uses the two-dimensional images a rover returns to Earth to display 3-D pictures of the Martian environment. With Viz teams can measure the rock surface areas and the distances between the rocks, with clicks of a mouse. The software predicts when and where on Mars the sun will cast shadows so that mission planners can capture good images and data.

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The framework:
CLARAty is a software framework that essentially bolts together the many other pieces of software that are controlling the rover and enabling people to interact with it. CLARAty is unique in that it works on many, different robots, and enables researchers at multiple institutions to build on each other's work. CLARAty, is a joint project of researchers from JPL, NASA Ames Research Center's Computational Sciences Division and Carnegie Mellon University, among others.

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